State Epidemiology Programs and State Epidemiologists: Results of a National Survey

ROBERT A. GUNN, MD, MPH
MARY C. WHITE, MS
GRAYSON B. MILLER, Jr., MD
J. LYLE CONRAD, MD, MPH
CARL W. TYLER, Jr, MD

Four of the authors are or were with the Epidemiology Program Office of the Centers for Disease Control. Dr. Gunn is Assistant Director, Dr. Conrad is Director, Division of Field Services, Ms. White, now retired, was a Biostatistician, Division of Surveillance and Epidemiologic Studies, and Dr. Tyler, formerly Director of the Office, is now in the Office of the Director, Centers for Disease Control. Dr. Miller is the State Epidemiologist, Division of Epidemiology, Virginia State Health Department, and former president, Council of State and Territorial Epidemiologists.

Tearsheet requests to Robert A. Gunn, MD, MPH, Epidemiology Program Office, Centers for Disease Control, Atlanta, Georgia 30333.

Ms. Barbara Sullivan, Ms. Joy Herndon, MS, and Ms. Donna Stroup, PhD, of the Division of Surveillance and Epidemiologic Studies, provided statistical analysis and consultation.

Synopsis

In 1983, the State Epidemiologists in 46 States completed a survey questionnaire describing the professional qualifications, training, and experience of State health department epidemiologists and the scope of participation by the State Epidemiologists and their staffs in public health programs. The survey identified 224 State health department epidemiologists (estimated U.S. ratio 1.1 per million population). A State health department epidemiologist was most often male (80 percent), frequently (57 percent) was a physician, had an average age of 41 years, and had worked as an epidemiologist for 9 years.

Participation in public health programs (either by supervising or providing consultation) by the State Epidemiologists and their staffs focused mainly on general epidemiology and communicable disease programs; fewer than half had participated in programs relating to the health of women and children, chronic diseases, injuries, or in other programs directed towards preventing premature mortality. Recently, the State Epidemiologists have been trying to broaden their activities into these areas; however, the demands created by the acquired immunodeficiency syndrome (AIDS) will mostly likely slow this process.

Based on the overall findings and collective experience, it was concluded that State health departments have too few epidemiologists to address the wide variety of important public health problems facing our communities. It was proposed that each State health department have at least four epidemiologists (including one or more physician epidemiologists) and at least one master's level biostatistician and that the epidemiologists-per-population ratio not be less than 1 per million.

During the period 1979–80, the Public Health Service published two consensus documents—"Healthy People" (*1*) and "Promoting Health/Preventing Disease: Objectives for the Nation" (*2*)—that described accomplishments in prevention efforts, identified major health problems, and set national strategies for reaching specific public health goals and objectives by 1990. Implicit in these documents was the need for public service epidemiologists and biostatisticians working in Federal, State, and local health agencies to develop regional, State, and community-specific data to identify health problems, measure progress toward meeting objectives, and develop additional information on disease causation and prevention. In a 1982 seminar directed towards identifying how the Public Health Service could assist State and local health agencies to meet the 1990 objectives, the need for epidemiology and biostatistics services was explicitly acknowledged (*3*).

State Epidemiologists and State Health Officers throughout the country have often stated that State epidemiology programs need to be strengthened so that epidemiology services can be applied to a broad range of health problems. In 1982, representatives of the national organization of State Epidemiologists (the Council [formerly Conference] of State and Territorial Epidemiologists [CSTE]) met with members of the Epidemiology Program Office, Centers for Disease Control (CDC), to discuss ways in which CSTE and CDC could collaborate to help States strengthen their epidemiology programs. A principal consensus of the meeting was that epidemiology programs in State health departments

varied considerably. Some State epidemiology programs actively used the basic tools of epidemiology—surveillance, investigation, analysis, intervention, and evaluation—to address a wide variety of public health problems, while in other States, epidemiology programs were less active and narrow in scope. As an initial step, a survey of State Epidemiologists in April 1983 developed quantifiable data about epidemiologists and epidemiology programs in State health departments.

The survey findings we report address the professional qualifications, training, and experience of State health department epidemiologists and describe the scope of participation in public health programs by the State Epidemiologists and their staffs. The findings are discussed with regard to the estimated need for epidemiologists and epidemiology services. In addition, we propose minimum staffing levels for a State health department epidemiology program.

Methods

The title "State Epidemiologist" usually designates the State health department epidemiologist responsible for overseeing the reporting of notifiable diseases to the National Morbidity Reporting System of the CDC. The State Epidemiologist's orientation has traditionally been towards surveillance and control of acute and communicable diseases. This orientation came about through the encouragement and financial support for States by CDC. Each State Health Officer was asked to name a State Epidemiologist, and financial support, in the form of grants, was provided for communicable disease control activities, most notably sexually transmitted disease control, tuberculosis control, and immunization programs. Over the years the role of the State Epidemiologist and other health department epidemiologists has evolved slowly to encompass a broader range of health problems; however, the State Epidemiologist still usually directs the health department's epidemiology and surveillance program and assists in information exchange with CDC on important public health issues. Because of this central focus in the health department and the networking of qualified epidemiologists, it is very likely that the State Epidemiologist would be knowledgeable about epidemiologists and epidemiology programs in his or her State health department.

Questionnaires were sent to the State Epidemiologist in all 50 States, New York City, and the District of Columbia in 1983. The State Epidemiologists were asked to identify "practicing epidemiologists" under their supervision (staff epidemiologists) as well as those in health department programs not under their supervision (other epidemiologists). They were asked to include as practicing epidemiologists persons who, based on training, job activities, and work output (investigations, reports, and presentations), demonstrated a proficiency in epidemiologic skills. Subsequently, in our analysis, we defined an epidemiologist as a person reported by the State Epidemiologist as a practicing epidemiologist who, in addition, had the following professional qualifications: (*a*) a doctoral degree in medicine (MD), veterinary medicine (DVM), or public health (DrPH), or (*b*) a doctoral degree (PhD) or equivalent with an epidemiology major, or (*c*) a master's degree in public health (MPH) or equivalent with an epidemiology major. Persons with a PhD or MPH whose major was not epidemiology or was not specified were not enumerated as epidemiologists. In addition, in this analysis each State Epidemiologist was classified as an epidemiologist regardless of professional degree or qualifications, and CDC Epidemic Intelligence Service (EIS) Officers and other CDC epidemiologists assigned to State health departments were also counted in this category. EIS Officers are generally young doctoral level professionals (mostly physicians) who are employed in a 2-year professional development program in public service epidemiology. Officers are assigned to State and local health departments as well as to CDC and other Federal agencies.

The scope of epidemiologic activities was assessed by asking the State Epidemiologists to indicate from a list of 43 public health programs which programs they supervised, which ones they or members of their staffs had consulted with during the previous 18 months, and the program's location (in a department of State government or elsewhere). The State Epidemiologist was considered as having participated in a program either by supervising it or by having provided consultation(s). The survey also requested additional information about the State health department and epidemiology program services (data not reported here).

For analysis, the States (including New York City and the District of Columbia) were grouped by regions; by population; by public health program participation level (high, middle, and low); and by an adjusted epidemiologists-per-population ratio (high, middle, and low). The epidemiologists-per-population ratio was adjusted by excluding the State Epidemiologist from the total of epidemiolo-

Epidemiologists in State health departments per million population in regions of the United States, 1983

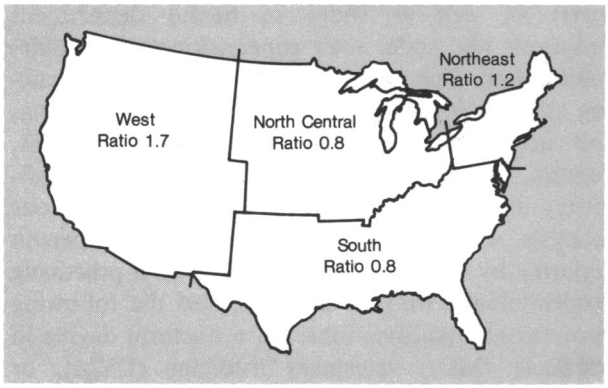

Table 1. Ratio of epidemiologists in State health departments, by region, 1983

Region	States surveyed		Population		Ratio of epidemiologists per million population
	Number	Percent[1]	Number (millions)	Percent[1]	
West	10	77	38	90	1.7
North Central	10	83	49	82	0.8
South	16	94	75	99	0.8
Northeast	10	100	49	100	1.2
United States	46	88	211	93	1.1

[1]Percent in region represented in survey.

gists in each State health department. The adjusted ratio was selected as an indicator of the State's epidemiology program services, and various demographic, epidemiology programmatic (services and structure), and the State Epidemiologists' characteristics were compared relative to this ratio by univariate methods and by a general linear models procedure for categorical and continuous data (analysis of covariance). Population data were from the 1980 census and economic data were from State government finances, 1982 (*4*).

Results

Questionnaires were returned by 46 (88 percent) of the State Epidemiologists, representing 93 percent of the U.S. population. The mean population per State, 4.5 million, was similar for each region.

Epidemiologists. The State Epidemiologists reported a total of 396 practicing epidemiologists. Of these, 224 (57 percent) met our study definition of an epidemiologist, 46 were the State Epidemiologists, 128 were staff epidemiologists, and 50 were other epidemiologists (health department epidemiologists not supervised by the State Epidemiologist). Of the 224 epidemiologists, 35 (16 percent) were CDC assignees, including 27 EIS Officers. The estimated overall U.S. epidemiologist-per-population ratio was 1.1 epidemiologist per million persons. The ratio was highest for the West Region (1.7, see map and table 1) and for States with a population of less than 1 million (3.2, ratio greater than 1.0 by definition since each State had at least one epidemiologist, the State Epidemiologist) and tended to decrease as State population increased (table 2). When the epidemiologists-per-population ratio was adjusted (the State Epidemiologists excluded), States with less than 1 million in population still had the highest ratio (1.7) and the same trend was evident (table 2). Overall, the number of epidemiologists per State averaged 4.9 (range, 1 to 31).

Table 3 shows selected characteristics of the 224 epidemiologists. Fifty-nine percent were physicians, and their distribution varied little by region or size of the State's population. The epidemiologists' mean age was 41 years and 80 percent were male. Slightly more than half (54 percent) had a public health degree with an epidemiology major; 27 percent were former EIS Officers, and 34 percent of the MDs and DVMs were board certified in preventive medicine.

State Epidemiologists identified 172 persons as practicing epidemiologists who did not meet the professional degree criteria of the definition of an epidemiologist used in this analysis. Compared to those 224 who did, these persons were slightly younger (38 versus 41 years) and were more often female (42 percent versus 20 percent). Their employment experience was similar to those classified as epidemiologists.

The State Epidemiologists. At the time of the survey, 44 (96 percent) of the 46 responding State Epidemiologists were State employees (41 permanent, 3 acting), and 2 were Federal CDC assignees. The State Epidemiologists' mean age was 44 years (median 40 years, range 32 to 65 years). Forty-three (93 percent) State Epidemiologists were male; the three female State Epidemiologists were in States with less than 3 million population.

The 46 State Epidemiologists had the following professional degrees: 34 (74 percent) had an MD degree, 6 (13 percent) a DVM degree, and the remaining 6 had other professional degrees. The six State Epidemiologists without an MD or DVM degree were located in States with populations of

Table 2. Epidemiologists in State health departments, by organizational location and State population, United States, 1983

Population	Office of State Epidemiologist		Other offices in health department		Total epidemiologists		Excluding the State Epidemiologists		
	Number	Ratio[1]	Number	Ratio[1]	Number	Ratio[1]	Number	Adjusted ratio[1]	Number per State
Less than 1 million (10 States)	20	2.9	2	0.3	22	3.2	12	1.7	1.2
1–3 million (11 States)	26	1.1	5	0.2	31	1.3	20	0.9	1.8
More than 3–5 million (11 States)	51	1.2	14	0.3	65	1.5	54	1.3	4.9
More than 5–10 million (8 States)	40	0.7	6	0.1	46	0.8	38	0.7	4.8
More than 10 million (6 States)	37	0.5	23	0.3	60	0.7	54	0.7	9.0
Total	174	0.8	50	0.2	224	1.1	178	0.8	3.9

[1]Ratio per million population.

Table 3. Selected characteristics of epidemiologists in State health departments, by employment position, United States, 1983

Employment position	Number	Age (mean years)	Percent male	Percent with PH degree, epidemiology major	Percent MD, DVM board certified preventive medicine	Percent EIS alumnus	Employment experience (mean years)		
							Public health	Epidemiology	Present position
State Epidemiologist	46	44	93	37	45	39	14	10	6
Staff epidemiologist	128	39	76	57	24	22	10	8	5
Other epidemiologist	50	41	78	66	51	30	11	9	4
Total or average	224	41	80	54	34	27	11	9	6

less than 3 million. Of the 34 physician State Epidemiologists, 21 (62 percent) also had an MPH (12 with a major in epidemiology) and 1 had a DrPH (epidemiology major). Sixteen (47 percent) of the 34 physician State Epidemiologists were board certified in preventive medicine and 9 (26 percent) were certified in other medical specialities. Of the six veterinarian State Epidemiologists, five were located in States in the South. Two were board certified in veterinary preventive medicine. Among State Epidemiologists in States with more than 3 million population, 60 percent were MDs or DVMs who were board certified in preventive medicine, compared to only 14 percent located in states with less than 3 million population. Eighteen (39 percent) of 46 State Epidemiologists were former EIS officers. In 1983 the mean time since completion of the EIS program was 7.7 years (median 4.5 years, range less than 1 to 26 years).

Staff and other epidemiologists. In addition to the State Epidemiologists, 178 epidemiologists meeting the criteria used in our analysis were located in State health departments: 128 staff and 50 other epidemiologists. Twelve States (26 percent) had both staff and other epidemiologists, 24 (52 percent) States had only staff epidemiologists, and in 10 (22 percent) States, the State Epidemiologist was the only epidemiologist in the State health department. These 10 States, however, contained only 7 percent of the population represented in this survey.

Of the 178 staff and other epidemiologists, 99 (56 percent) had an MD degree, 24 (13 percent) had a DVM degree, 15 (8 percent) had a DrPH degree (14 with an epidemiology major), 12 (7 percent) had a PhD with an epidemiology major, and 28 (16 percent) had an MPH with an epidemiology major. Of the 99 persons with an MD, 59 (60 percent) also had an MPH degree. Of the physicians, 36 (36 percent) were board certified in preventive medicine, as were 2 (8 percent) of the veterinarians. Of the 178 staff and other epidemiologists 43 (24 percent) were former EIS Officers (38 MDs and 5 DVMs).

Public health program participation. Of the 43 public health programs listed, the 46 State Epidemiologists supervised 16 percent (324 of a possible 1,978 or 43 programs × 46 States) and participated in a total of 45 percent, either by supervising 324 or providing consultation to 575 programs. The programs, by percentage of State Epidemiologists' participation, are shown in table 4. More than 75 percent of State Epidemiologists participated in general epidemiology and communicable disease programs. Fewer than half of them participated in programs concerned with birth defects, tumor registry, public health vital statistics, maternal and child health, smoking cessation, or injury control. Fewer than 25 percent participated in the following

Table 4. Supervision of or consultation on 43 public health programs by State Epidemiologists and their staffs and organizational location, United States, 1983 (percentages)

Program or activity	Participation	Supervision	Located in State health department[1]
	Participation by >75 percent of State Epidemiologists		
Communicable disease control	100	93	93
Epidemiology	96	91	91
Sexually transmitted disease	96	63	93
Immunization	96	59	93
Noncommunicable disease control	92	61	93
Tuberculosis	86	57	93
Veterinary public health	78	48	57
	Participation by > 50–75 percent of State Epidemiologists		
Cancer control	67	26	83
Laboratory services	65	4	89
General environmental health	65	9	86
Hazardous waste	61	4	50
Occupational health	61	17	63
Vector control	61	7	61
Chronic disease	59	20	86
Hypertension	52	17	93
Behavioral risk factors	52	17	80
	Participation by 25–50 percent of State Epidemiologists		
Health education	50	7	86
Birth defects	43	4	74
Diabetes	43	20	80
Tumor registry	43	9	52
Radiological health	39	2	85
Sewage disposal	39	0	52
Vital statistics	39	7	93
Maternal and child health	39	7	93
Lead screening	37	7	72
Shellfish sanitation	35	0	41
Smoking prevention	35	9	63
Migrant health	35	7	57
Rheumatic fever	33	15	57
Injury control	33	2	63
Solid waste disposal	30	0	48
Water supply engineering	28	0	63
Personal health	26	0	67
	Participation by <25 percent of State Epidemiologists		
Fluoridation	24	4	85
Infant screeening	20	2	89
Nutrition	20	7	89
Pesticide applicator screening	20	0	89
Alcohol abuse	17	2	57
Kidney disease	15	7	57
Family planning	13	2	86
Improved pregnancy	11	2	89
Drug abuse	11	0	52
Women, infants and children (WIC)	9	2	91

[1]If program was not located in State health department, it did not exist or was in another State agency.

programs—infant screening, nutrition, alcohol abuse prevention, family planning, improved pregnancy outcome, drug abuse prevention, or women, infants, and children (WIC) programs. The State Epidemiologists' participation in public health programs was similar by region of the country and by size of the State's population.

Epidemiologists per population. The adjusted epidemiologists-per-population ratio ranged from 0 to 4.2 per million. The range of ratios divided into three categories was as follows:

High—1.3 to 4.2 for 15 States with a population mean of 3.9 million
Middle—0.4 to 1.2 for 15 States with a population mean of 5.5 million
Low—0 to 0.3 for 16 States with a population mean of 4.4 million

The distribution of the high, middle, and low ratio States was similar by region of the country.

The ratio of licensed physicians per population was similar for the high (1.9) and middle (2.0) categories, but it was lower (1.6) for the low epidemiologists ratio category. State expenditure per capita for public health was highest for the high epidemiologist ratio category ($28.20, $22.26, and $13.98, high to low respectively).

Among the three categories of ratios of epidemiologists per population, there were a number of similarities. The extent to which State Epidemiologists supervised the 43 public health programs was almost equal—17 percent for the high and middle group, 16 percent for the low ratio. Participation in programs was similar also—47 percent for the high and middle group and 42 percent for the low ratio. State Epidemiologists in the high ratio category were more often former EIS Officers (53 percent of the high group, 40 percent of the middle, and 25 percent of the low group). The characteristics of the staff and other epidemiologists were similar in all three categories. The general linear models procedure showed that the variables licensed-physicians-per-population ratio ($P = 0.0004$), expenditure per capita for public health ($P = 0.003$), and the State Epidemiologist being an alumnus of the EIS program ($P = 0.03$) were each jointly associated with a higher epidemiologists-per-population ratio.

Discussion

In beginning to assess State epidemiology programs relative to epidemiologists currently employed by state health departments and estimates for future needs, we first had to define an epidemi-

ologist. During the past decade, a variety of studies and reports have attempted to determine the number of practicing epidemiologists in the United States, and to estimate future needs (*5–10*). The authors of these studies had the problem of defining an epidemiologist because, unlike medical specialties, there has not been a certifying mechanism for epidemiologists until recently (the American College of Epidemiology). Therefore, in formulating a definition of an epidemiologist, investigators usually try to balance self-proclamation, formal training, practical experience, and various indicators of epidemiologic practice.

In our study, we faced the same definitional problem. We started by casting a wide net, using the State Epidemiologist as a focal point, to identify all practicing epidemiologists in State health departments and then, in our subsequent data analysis, we refined the definition by applying specific professional and formal training criteria to the group initially identified. Even with this approach there are some misclassifications—omission of some persons who were epidemiologists and incorrect identification of others who were not. These errors occurred probably because the data were reported from a single source and the suggested definition of a practicing epidemiologist was broadly based, using a composite of indirect indicators that required subjective interpretation (that is, demonstration of epidemiologic skills). However, we are reasonably confident that the State Epidemiologists would very likely know and report all epidemiologists in the State health departments because the network of professionally qualified epidemiologists is relatively small, and none of the respondents noted that they had difficulty identifying epidemiologists in other program areas. Thus, there were probably few omissions; however, the State Epidemiologists might tend to list persons on their staffs as practicing epidemiologists although they were not formally trained or capable of independently practicing epidemiology. We feel that by applying specific criteria that emphasized professional credentials and formal epidemiology training we would greatly improve the predictive value of our definition. In addition, because we used such an emphasis, the interpretation of the survey results are referable not only to formally trained epidemiologists but to epidemiologists who most likely have the authority and professional standing to introduce and direct epidemiologic activities to major public health problems.

In regard to the scope of work being done by epidemiologists, our 1983 survey indicated that many State health department epidemiologists were not addressing a broad range of health problems but were only applying their skills in the traditional field of disease control—primarily communicable disease. In less than half the States were the State Epidemiologists and their staffs working with programs that address the major public health areas that have considerable impact upon the health of children and potential years of life lost such as maternal and child health; improved pregnancy outcome; birth defects; women, infants, and children programs; and injuries. In some of the large population States, such programs may have had input from epidemiologists directly assigned to them; however, only 12 (26 percent) State Epidemiologists reported that there were other epidemiologists in the health department but not on the State Epidemiologist's staff. In addition, only 50 such other epidemiologists were enumerated; and one State accounted for 17 of these 50. For the remaining States, however, our findings confirm the lack of input from professionally trained epidemiologists in the many programs aimed at addressing major public health problems.

'In less than half the States were the State Epidemiologists and their staffs working with programs that address the major public health areas that have considerable impact upon the health of children and potential years of life lost such as maternal and child health; improved pregnancy outcome; birth defects; women, infants, and children programs; and injuries.'

On the other hand, it is likely that programs managed by public health professionals received some epidemiologic input from these managers or from staff members who may have learned epidemiologic approaches and techniques from courses or on-the-job experience. For example, a well-trained maternal and child health specialist should know and apply epidemiologic principles in guiding programs; however, in this study we did not collect data specific to this issue. In addition, the State Epidemiologists named 172 persons (mean 3.7 per State) whom they considered epidemiologists but who lacked the professional credentials or formal training we used to enumerate epidemiologists in

Table 5. Distribution of States according to proposed levels of epidemiologists staffing for State health departments, United States, 1983

Level	Staffing levels: 4 epidemiologists and 1 epidemiologist per million population[1]			4 epidemiologists and 2 epidemiologists per million population[2]		
		Epidemiologists			Epidemiologists	
	States	Needed to meet level	Above level	States	Needed to meet level	Above level
Below	27	86	...	37	216	...
Meets	5	...	...	2	...	...
Above	14	...	51	7	...	18
Total	46	86	51	46	216	18

[1]Minimum proposed staffing level for States is 4 epidemiologists (as defined in this report and includes at least 1 physician epidemiologist) and a ratio of not less than 1 epidemiologist per million population. Presence or absence of a biostatistician not included in determination.

[2]Minimum criteria with higher ratio per population.

this analysis. No doubt these persons provided epidemiologic input in a variety of programs.

These data describe the program participation by epidemiologists in 1983, and since that time States have been attempting to apply epidemiology more broadly in public health prevention and control programs. Specific funding may be needed, as was done for acute communicable disease control previously, to expand epidemiology activities more rapidly. Recently, this has occurred to some extent through specific funding in the areas of chronic diseases, injuries, and occupational health. On the other hand, the demands placed on epidemiology and other services by work related to AIDS will compete for epidemiologic resources in State health departments and may slow some of the movement to expand epidemiology program activities. Another survey is needed to describe the epidemiology services currently being provided in State health departments.

As an indicator of the breadth of epidemiology services, we used the epidemiologists-per-population ratio and adjusted it by excluding the State Epidemiologists. The rationale for excluding the State Epidemiologists from the ratio was that States with small populations (less than 1 million) and a single epidemiologist—the State Epidemiologist—would tend to have a spuriously high ratio (at least more than 1.0 per million) that would likely be an unreliable indicator of epidemiology services. Using this calculation method, the adjusted epidemiologists ratio ranged from 0 to 4.2 per million and was not associated with the level (high, middle, or low) of participation in public health programs by the State Epidemiologists and their staffs. This finding was unexpected, since we thought that States with more epidemiologists per population would have the capacity to participate in a wide variety of public health programs. However, the index level of participation we used, which was primarily a measure of consultations with public health programs, did not measure the frequency, nature, or quality of these consultations. Had these characteristics been measured and used as an index of public health program participation, an association with a higher ratio of epidemiologists per population might have been evident.

With our data, the adjusted epidemiologists-per-population ratio could best be predicted by two State characteristics and one characteristic of the State Epidemiologist. The fact that the ratio was associated with the number of licensed physicians per population implies that where practicing physicians locate so do epidemiologists—many of whom are also physicians. The association with States that have a higher per capita public health expenditure suggests that those States provide more resources for program development, support staff, and probably salary; however, we did not collect information on epidemiology program budgets or salary scale. Lastly, if the State Epidemiologist was an alumnus of the EIS program, it may be a reflection of his or her training and appreciation of the value of epidemiology and of the need for an adequate number of staff epidemiologists.

The estimated ratio of 1.1 million epidemiologists per population for State health departments in the United States derived from our data is higher than the 0.8 per million obtained in a similar 1977 survey (*5*). That survey used a respondent-determined definition of an epidemiologist both for data collection and analysis and identified 171 epidemiologists. Had the professional degree criteria of our analysis definition been applied, the number of epidemiologists enumerated would have

decreased to 126 (ratio of 0.6 per million). Thus, the 1983 ratio of 1.1 per million represents an 83 percent increase from the comparable 1977 ratio of 0.6. In addition, in 1977 only six States had epidemiologists (N = 19) working on noncommunicable disease problems; in 1983 at least 12 States had 50 other epidemiologists (not on the staff of the State Epidemiologists) who were working on noncommunicable disease problems in public health.

Investigators in a 1985 study of the supply of and need for practicing epidemiologists which used a variety of interviews, cross-referencing of epidemiology publication subscription lists, and other techniques, estimated that there were 4,000–4,500 practicing epidemiologists (ratio 18.2–20.5 per million) in the United States (*10*). In this study, a sample of epidemiologists representing 22 States was interviewed regarding the number of public service epidemiologists (undefined) in their State (data not reported in manuscript), and from that data the authors estimated one State-employed epidemiologist per 650,000 population (1.5 per million) which is slightly higher than our estimate.

Regardless of the total number of epidemiologists practicing in the United States, we conclude that the number practicing in State health departments needs to be increased substantially. It is apparent that, to deliver basic epidemiology services, each State needs more than one epidemiologist and, as its population increases, the delivery of services becomes more complex and requires more epidemiologists. Based on our collective experience, we propose that, at a minimum, each State health department have four epidemiologists (including one or more physician epidemiologists) and one master's-level biostatistician and that the epidemiologists-per-population ratio not be less than 1 per million. The number of epidemiologists needed in 1983 to meet this proposed minimum staffing level and the number needed to maintain a higher level of 2 epidemiologists per million population is shown in table 5. However, considering the impact of human immunodeficiency virus and AIDS and environmental toxic contaminations (the need for Superfund evaluations, for example) even these minimum proposed staffing levels may be inade quate to meet the demands for epidemiologic services presently being placed upon State health departments.

Epidemiologists in State health departments over the years have provided a very valuable service to their States and to the national efforts in disease surveillance and control. In many instances, they were the first to identify significant public health problems, initiate investigations, and collaboratively work with community groups, schools of public health, university medical schools, and other State and Federal agencies in bringing about a resolution of these problems. As their scope of responsibility moves from principally communicable disease control to a much broader spectrum of public health problems, the need for public service epidemiologists is sure to grow. Attaining the goals and objectives outlined in "Promoting Health/Preventing Disease" (*2*) will be a challenge for epidemiologists everywhere—in State and local health departments, Federal health agencies, and academic centers—as well as for all members of the public health community.

References

1. Healthy people: the Surgeon General's report on health promotion and disease prevention. DHEW (PHS) Publication No. 79-55071, U.S. Public Health Service, Washington, DC, 1979.
2. U.S. Public Health Service: Promoting health/preventing disease: objectives for the nation. Washington, DC, 1980.
3. Centers for Disease Control: Implementing the 1990 prevention objectives: summary of CDC's seminar. MMWR 32:21-24, Jan. 21, 1983.
4. The book of the States 1984–1985. Council of State Governments, Lexington, KY, 1985, pp. 324–325.
5. Hinman, A. R.: State health departments. *In* Tracing the patterns of disease: the role of epidemiology and biometry, edited by J. E. Fogarty. NIH Publication No. 77-1285, International Center for Advanced Study in the Health Sciences, DHEW, Washington, DC, 1977, pp. 67–81.
6. White, K. L.: Opportunities and needs for epidemiology and health statisticians in U.S. *In* Epidemiology as a fundamental science, edited by K. L. White and M. M. Henderson. Oxford University Press, New York City, 1976, pp. 67–83.
7. Detels, R.: The need for epidemiologists. JAMA 242:1644–1646 (1979).
8. U.S. Department of Health and Human Services: Public health personnel, 1980. DHHS Publication No. (HRA) 82-6, U.S. Government Printing Office, Washington, DC, 1982.
9. Henderson, M. M.: Needs and resources for epidemiology and health statisticians in the U.S. *In* Epidemiology as a fundamental science, edited by K. L. White and M. M. Henderson. Oxford University Press, New York City, 1976, pp. 84–96.
10. Williams, S. J., et al.: Epidemiologists in the United States: an assessment of the current supply and anticipated need. Am J Prev Med 4:231-238 (1988).